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The Proper Motion of Small Stars. By S. W. Burnham.

Small stars having any sensible proper motion which can be detected by meridian or micrometric observations, so far placed on record, are much rarer than parallax stars taken from all magnitudes, bright and otherwise. Very few examples have been detected down to this time, although more or less searched for by all double-star observers and others using the micrometer for determining the relative positions of stars. The small stars referred to may be generally classed as below the limiting magnitude of the Durchmusterung, or from the tenth magnitude to the faintest stars which have been accurately measured by large instruments. Of course it is to be expected that this apparent fixity in space would be found in the great majority of instances; or that the motion would be so small that it could not possibly be separated from the unavoidable errors of observation in the most careful measures by all astronomical instruments. Therefore these small stars furnish by far the best means of determining any change in the position of brighter stars when the distance is within reach of the micrometer, and give the proper motion of the large stars more accurately than any number of positions with the meridian circle from the beginning of such observations, provided the interval of time covered by the micrometer measures is sufficient to practically eliminate the smaller errors of that instrument. So, when the prominent stars have been connected by measures with faint stars in the field by the Struves and other old observers, we have a value of the proper motions of the large stars which is a safe and certain correction to that given by meridian positions.

It is hardly necessary to say in this connection that the faint stars referred to have nothing to do with a large and distinct class of these objects which are moving in space with much brighter stars, and at exactly or nearly the same rate, and in substantially parallel directions. We have a large number of these attending stars, some of them of the smallest magnitudes visible in the largest refractors, and in brightness anywhere between that and the naked-eye star. In many instances the moving stars are separated by several minutes of arc. Whether these constitute binary systems in the ordinary sense of the term, or what common proper motion of stars so remote from each other implies, is, at this time, a matter of speculation only, and must necessarily remain so until careful observations have been made, extending over possibly several hundreds of years. That these stars have something in common seems to be at least highly probable. A large number of systems of this class will be found in my *General Catalogue of Double Stars*, indexed in Part I. under "Common Proper Motion," and "Stars of the 61 Cygni type."

One of the very few examples I have been able to find, and

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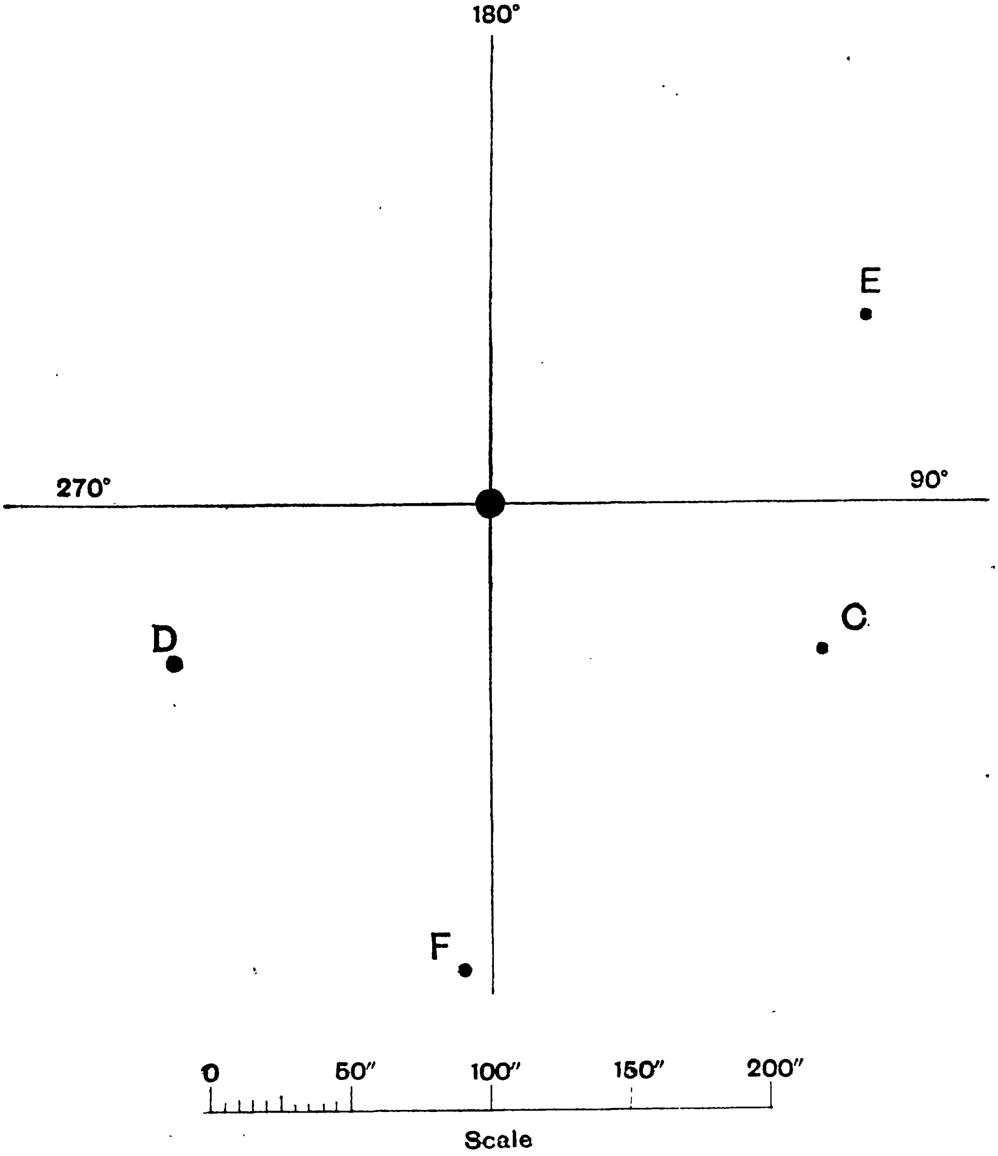
perhaps the only one worth mentioning, of an isolated small star having a decided proper motion, is a faint star of about the twelfth magnitude in a low-power field with 17 *Lyræ* (Σ 2461). The observations of this star are sufficient in point of time to show that it has a remarkable movement, and one without any parallel in



17 *Lyræ.*

stars of the lower magnitudes, so far as appears from reliable observations of any kind.

The diagram shows the positions of this and other small stars which have been measured from 17 *Lyræ.*

The magnitudes of the three smaller stars have been measured photometrically by Mr. F. C. Jordan of the Yerkes Observatory.

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The magnitude of the large star D, which is DM 32°, 3325, is assumed to be 9·0.

C = 12·00 mag.
E 10·96
F 10·87

My measures of these stars with the 40-inch are :—

A and C.

1905·717	66°·4	127″·37
5·720	66·4	127·73
5·736	66·5	127·66
6·906	66·1	129·53
6·964	66·1	129·46
7·258	66·1	130·01
7·271	66·2	130·14
7·291	66·3	130·38

A and D.

1906·906	295°·5	126″·51
6·964	295·6	126·51
7·258	295·7	126·03
7·271	295·3	126·32
7·291	295·7	126·61

A and E.

1906·906	116°·5	150″·93
6·904	116·6	150·77
7·258	116·9	150·86
7·271	116·7	150·85

A and F.

1906·906	356°·7	167″·54
6·964	356·8	167·47
7·271	357·2	167·71

For the relation of A and C we have the following earlier positions by Engelhardt :—

1887·81	72°·02	102″·28	1n	Eng.
1894·85	69·23	112·31	2n	Eng.
1905·72	66·40	127·59	3n	β
1907·14	66·16	129·90	5n	β

These positions give for the most probable apparent annual motion of C :—

1″·542 in 45°·9.

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The large star, 17 *Lyræ*, has a small proper motion which is given from meridian observations:—

0″·112	in 68°·5	Auwers.
0·121	in 74·8	Newcomb.

A more accurate value of this movement can be found from the measures of the other distant stars which it is certain have no sensible proper motion. These positions are:—

A and D.

1887·73	296°·40	124″·34	2n	Eng.
1894·85	296·00	125·32	2n	Eng.
1905·72	295·70	126·12	1n	β
1907·14	295·56	126·40	5n	β

A and E.

1887·81	116°·00	152″·65	1n	Eng.
1894·85	116·37	152·20	1n	Eng.
1905·72	116·50	150·75	1n	β
1907·10	116·67	150·85	5n	β

A and F.

1887·73	357°·77	168″·20	2n	Eng.
1894·85	357·50	168·11	2n	Eng.
1907·05	356·90	167·57	3n	β

These measures give for the proper motion of 17 *Lyræ*:—

AD	R.A. +0″·1263	Decl. +0″·0342
AE	0·1260	0·0224
AF	0·1307	0·0402
Mean	0·1277	0·0323

Therefore the corrected proper motion is:—

0″·132 in 75°·8.

Applying this to the apparent movement of C, we have for the real proper motion of that star:—

1″·658 in 48°·2.

A photographic plate of this field was taken 1907·444 with the 40-inch. With a Wallace colour screen, and an exposure of about fifteen minutes, the resulting negative was beautifully sharp and well defined, and practically perfect for measuring the relative positions of the several stars.

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As direct measurement of the position-angle cannot be made with any instrument here, the measures of this plate were confined to distances. The mean results of six sets of measures by four observers are as follows:—

AC =	130″·58
AD	126·40
AE	150·92
AF	167·78
CE	121·72

A study of the details of these measures seems to show that they have about the same accuracy as those made under the best conditions with the micrometer, and that the uncertainty of the result is probably less, or not more, than 0″·2.

Whether a proper motion star of this magnitude is more likely to have a parallax large enough for certain measurement, which should be at least 0″·3, by either or both methods, than a twelfth magnitude star taken at random, is a matter to be determined hereafter, but it would not be unreasonable to presume that such a star might be nearer our system.

There is one other example of proper motion in a small star, but nearly three magnitudes brighter than the one already referred to, which was discovered by Dr. Max Wolf in his photographic researches (*A.N.*, 4101) by the change shown on plates made in 1892 and 1906. This is a 9·2*m* star, not given in the *D.M.*, the place (1900) of which is—

R.A. = $11^{h}\ 23^{m}\ 20^{s}$
Decl. = 8° 6′ 1″

There is a similar star, given by Wolf as 9·1*m*, closely preceding; and a 13*m* star more distant in the same quadrant. I have made two sets of measures of these stars as follows:—

A and B. (9·7—9·7.)

	°	″
1906·906	252·1	81·63
7·006	252·0	81·68
7·102	252·1	81·42
7·120	252·2	81·44
1907·03	252·1	81·54
	°	″
1908·118	253·2	80·92
·156	253·1	81·11
·159	253·1	80·68
·192	253·0	80·82
1908·15	253·1	80·88

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B and C. (12·0.)

1906·906	275°·9	155″·17
7·102	275·5	154·48
7·120	275·7	154·17
1907·04	275·7	154·61

1908·118	275°·9	154″·90
·159	275·8	154·70
·192	275·7	154·50
1908·15	275·8	154·70

As Dr. Wolf gives no measures of the relations of these stars which can be utilised in this connection, I have measured as carefully as possible their positions on the paper print for comparison with the micrometer positions, with the following results:—

A and B.

1892·23	242°·1	91″·47		Wolf.
1907·03	252·1	81·54	4n	β
1908·15	253·1	80·88	4n	β

B and C.

1892·23	275·9	154″·94		Wolf.
1907·04	275·7	154·61	3n	β
1908·15	275·8	154·70	3n	β

It is evident that the comparison star B has no proper motion, and that the change shown by the measures of AB is due wholly to the proper motion of A. A comparison of the position in 1892 with a mean of the two later measures gives for the proper motion of A:—

1″·225 in 190°·2.

The minimum distance of A and B of 72″ will be reached in about thirty years, after which they will slowly separate.

The 7·5*m* star, DM 8°, 2512, which is 70^s following and 185″·7 south, has a 13·2*m* companion not heretofore observed:—

1907·12	285°·0	18″·37
·14	286·3	18·37

I do not find any proper motion assigned to this star.

Yerkes Observatory:
April 10.

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New Double Stars. By the Rev. T. E. Espin, M.A.

No.	B.D.	R.A.	1900.	Decl.		P.	D.	Mags.		Nights.	Date.	
		h	m	°	′	°	″				1908.	
552	+56°,143	0	47·4	+56	41	85·9	12·60	7·0	13·0	2	·015	
553	+45,405	1	33·5	45	32	144·1	5·15	8·8	9·2	3	·014	
554	+42,549	2	27·4	42	32	24·9	5·80	9·1	9·3	1	·099	
555	+41,501		32·0	41	46	323·9	9·62	8·5	11·5	2	·083	
556	+41,543		42·2	42	0	352·7	6·40	8·4	10·7	2	·073	
557	+47,712		44·3	47	41	315·8	5·04	9·1	12·4	4	·075	
558	+45,710	3	0·0	45	22	357·8	8·47	7·5	9·4	2	·082	
559	...		6·8	43	54	250·6	3·17	9·3	11·2	2	·116	
560	+45,784		26·3	45	55	140·8	8·60	8·4	10·1	3	·091	
561	+45,787		26·6	45	25	38·8	7·40	8·9	9·1	2	·087	
562	+44,769		34·0	44	17	358·4	2·91	9·3	11·7	5	·066	
563	+44,809		47·6	44	35	23·3	6·14	9·0	12·6	4	·082	
564	+42,876		56·7	42	30	115·3	2·29	8·9	9·3	4	·117	
565	+42,890	4	0·0	42	35	62·2	4·75	9·3	10·6	2	·090	
566	+46,881		18·5	46	19	281·3	5·10	9·4	12·0	3	·106	CD
						150·2	11·10	8·9	10·8	2	·097	AB
						148·0	27·15			2	·097	AC
567	+44,945		18·7	45	1	128·9	7·97	8·8	9·4	3	·106	BC
						351·8	36·32	A =	8·8	2	·097	AB
568	+42,969		20·7	42	58	304·3	5·07	7·7	12·0	2	·083	
569	+44,967		24·5	44	43	19·5	7·72	9·0	12·8	3	·122	
570	+41,898		26·8	41	15	178·7	3·90	9·1	13·0	1	·153	
571	+48,1146		39·9	49	3	59·9	3·35	9·1	9·2	2	·143	
572	+41,966		41·9	41	28	93·1	3·05	8·8	12·0	1	·153	
573	+42,1228	5	9·4	42	33	122·9	5·01	8·0	10·5	3	·040	
574	+47,1122		10·3	47	12	87·7	1±	9·7	10·3	3	·108	BC
						63·1	33·65	A =	9·4	3	·108	AB
575	+48,1264		16·9	48	16	353·6	14·35	8·1	10·7	3	·113	
576	+42,1274		17·2	42	31	342·8	8·45	8·0	13·7	2	·015	AB
						236·3	42·35		8·2	2	·015	AC
577	...		17·3	47	17	133·5	2·30	9·7	11·5	2	·101	
578	+49,1403		40·2	49	22	41·7	2·02	9·1	9·2	2	·131	
579	+47,1249	6	1·0	47	26	115·3	6·57	8·5	11·0	2	·119	BC
						341·3	57·00	A =	8·3	2	·119	AB
580	+44,1380		4·0	44	45	226·3	6·85	9·0	9·4	3	·078	AB
						119·2	22·30	C =	12·0	1	·082	AC
581	+49,1470		7·3	49	0	61·6	3·25	8·8	11·5	2	·121	
582	+44,1492		29·4	44	10	301·9	6·18	9·6	12·3	3	·107	
						79·0	33·92	A =	9·3	3	·107	
583	+44,1527		38·0	44	35	69·4	4·67	9·4	9·6	4	·082	